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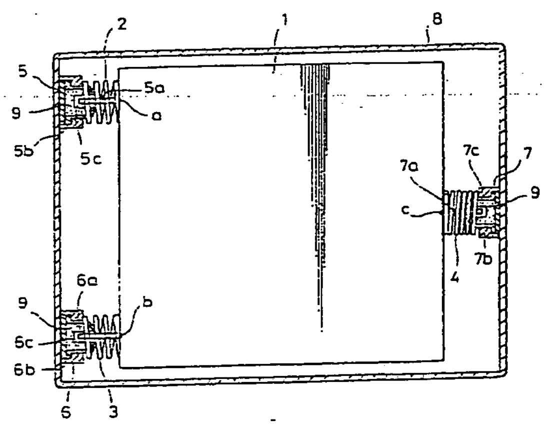
(54) Shock absorber device.

(57) A shock absorbing device including a chassis (1), a frame (8) surrounding the chassis, and a plurality of supporting devices for resiliently supporting one side of the chassis (1) and the opposing other side of the chassis (1) to the frame (8). Each of the supporting devices comprises a rod (5a,6a,7a), a damper (5,6,7) formed of a resilient member (5b,6b,7b) and having an engagement concave portion (5c,6c,7c) into which the rod (5a,6a,7a) is fitted, and a coil spring (2,3,4) surrounding the rod (5a,6a,7a) and being disposed between the chassis (1) and the frame (8) under compressed state. The coil springs (2,3,4) have spring constants of the shearing direction respectively set in response to the direction of the action of gravity on the chassis (1), and disposed at one side and the other opposing side of the chassis (1) so that the compressing directions of the coil springs (2,3,4) are opposed to each other.

FIG. 1



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The present invention relates to shock absorber devices and has particular though not exclusive application to a shock absorber device for use with portable electronic apparatus.

Patents Specifications US-A-4,731,777 and 4,794,588 describe a shock absorber mechanism utilized in a conventional mobile apparatus or the like in which a chassis is suspended from a frame by a tension coil spring.

Such a shock absorber mechanism in which the chassis is suspended from the frame by the tension coil spring can achieve a shock absorbing effect when the direction in which the apparatus is disposed is determined. However, when the conventional shock absorber mechanism is utilized under the condition that the direction in which the apparatus is disposed is not yet determined, for example, when this apparatus is disposed upside down in the vertical direction, the chassis cannot be suspended by the tension coil spring. There is then the disadvantage that a predetermined shock absorbing effect cannot be achieved.

Further, there is proposed a portable optical disc player in which compression coil springs are respectively disposed above and below a chassis on which ther are provided some devices such as an optical pickup device or the like.

The previously-proposed portable optical disc player in which compression coil springs are respectively disposed above and below the chassis needs at least three compression coil springs on the upper chassis portion and three compression coil springs on the lower portion, i.e., six compression coil springs in total in order stably to support the chassis. Therefore, this conventional portable optical disc player becomes complicated in arrangement.

According to the invention, there is provided a shock absorbing device comprising:

a) a chassis;

b) a frame surrounding the chassis; and

c) a plurality of supporting means for resiliently supporting one side of the chassis and the opposing other side of the chassis to the frame, wherein the supporting means each comprise a rod, a damper formed of a resilient member and having an engagement concave portion into which the rod is fitted, and a coil spring surrounding the rod and being disposed between the chassis and the frame under compressed state, the coil springs having spring constants of the shearing direction respectively set in response to the direction of the action of gravity on the chassis, and being disposed at one side and the other opposing side of the chassis so that the compressing directions of the coil springs are opposed to each other.

Such a shock absorber device can be of a relatively simple arrangement but can achieve equal shock absorbing effects regardless of all directions in which a portable device is placed and all directions in which a vibration is applied. The chassis can be stably held even when it is moved within the frame by gravity acting on the chassis. The shock absorber device can achieve a stable shock absorbing effect and preferably can be miniaturized.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:

FIG. 1 is a plan view showing a shock absorbing device according to an embodiment of the present invention in a partly cross-sectional fashion;

FIG. 2 is a cross-sectional view illustrating the condition that the shock absorbing device shown in FIG. 1 is placed on the horizontal plane;

FIG. 3 is a cross-sectional view illustrating the condition that the shock absorbing device shown in FIG. 1 is placed in the lateral direction (spring-shearing direction);

FIG. 4 is a cross-sectional view illustrating the condition that the shock absorbing device shown in FIG. 1 is placed in the lateral direction (spring-compression direction);

FIG. 5 is a plan view showing the shock absorbing device according to another embodiment of the present invention in a partly cross-sectional fashion;

FIG. 6 is a bottom view showing a disc driving apparatus to which the shock absorbing device of the present invention is applied in actual practice; and

FIG. 7 is a schematic diagram showing a supporting portion formed of a compression coil spring and a damper mechanism in an enlarged scale.

A shock absorbing device of the present invention will hereinafter be described with reference to the drawings.

Referring to FIG. 1 of the accompanying drawings, there is shown a chassis 1 on which some assembly parts such as an optical pickup device, a disc table or the like (not shown) are mounted. There is provided a frame 8 which forms a housing in this embodiment. The frame 8 is formed of a flat- shaped box that surrounds the chassis 1.

In this embodiment, the chassis 1 is supported to the frame 8 by means of supporting portions which comprise three compression coil springs 2, 3, 4 and three dampers 5, 6, 7 made of a synthetic rubber or the like, respectively.

As shown in FIG. 1, in this embodiment, on the left-hand side of the chassis 1, two compression coil springs 2, 3 and the dampers 5, 6 serving as resilient members are disposed symmetrically with respect to the centre line in the horizontal direction. On the other hand, on the central position at the right-hand side of the chassis 1, there are disposed one compression coil spring 4 and the damper 7 serving as a resilient member. The compression coil springs 2, 3 and the

compression coil spring 4 are disposed so as to spring-bias the chassis 1 in the opposing direction accordingly.

The dampers 5, 6, 7 comprise rods 5a, 6a, 7a and containers 5b, 6b, 7b into each of which there is sealed a viscous fluid 9 such as a silicon oil or the like, respectively. The rods 5a, 6a, 7a are fixed to the chassis 1 and the containers 5b, 6b, 7b are fixed to the frame 8. The rods 5a, 6a, 7a are fitted into engagement concave portions 5c, 6c, 7c of the containers 5b, 6b, 7b with pressure, respectively.

The compression coil springs 2, 3 and 4 are respectively held between the containers 5b, 6b, 7b and the side walls of the chassis 1, while the rods 5a, 6a, 7a of the dampers 5, 6, 7 are used as cores thereof, respectively.

In this case, the dead weight of the chassis 1 is mainly supported by the compression coil springs 2, 3, 4 which are disposed on the left and right of the chassis 1 in an opposing relation to each other.

In this embodiment, assuming that spring constants of the compression coil springs 2, 3, 4 in the compression direction are $k\alpha 2$, $k\alpha 3$ and $k\alpha 4$ and that loads (N) that are produced by the compression of the compression coil springs 2, 3, 4 when the compression coil springs 2, 3, 4 are attached are P_2, P_3, P_4, then we have:

$$P_2 + P_3 = P_4 \quad (1)$$

A resonance frequency foa in the spring compression direction at that time is determined by the following equation (2):

$$fo\alpha = \frac{1}{2\pi}\sqrt{\frac{k\alpha 2 + k\alpha 3 + k\alpha 4 + 3k\alpha}{M}} \quad (2)$$

where $k\alpha$ is the dynamic spring constant of the dampers 5, 6, 7 in the compression direction and M is the mass of the chassis 1.

Furthermore, in this embodiment, spring constants k2, k3 and k4 of the compression coil springs 2, 3 and 4 in the shearing direction are determined as follows. Assuming that gravities applied to attachment points a, b and c of the compression coil springs 2, 3 and 4 to the chassis 1 are respectively m2g, m3g and m4g, then we have:

$$\frac{k_2}{m2g} = \frac{k_3}{m3g} = \frac{k_4}{m4g} \quad (3)$$

At that time, the amounts that the compression coil springs 2, 3 and 4 are deformed at the attachment points a, b, and c become equal.

A resonance frequency $fo\beta$ of the compression coil spring in the shearing direction at that time is expressed as:

$$fo\beta = \frac{1}{2\pi}\sqrt{\frac{k2 + k3 + k4 + k\beta}{M}} \quad (4)$$

where $k\beta$ is the dynamic spring constant of the dampers 5, 6, and 7 in the shearing direction.

With the above-mentioned arrangement, when the apparatus body is placed in the horizontal direction (see FIG. 2) or when the apparatus body is placed in the lateral direction (see FIGS. 3 and 4), the chassis 1 is sunk by its own gravity applied thereto. Therefore, according to this embodiment, a clearance between the chassis 1 and the frame 8 is selected to be larger than respective sinking amounts T_1, T_2, and T_3.

When the apparatus body to which the above-mentioned shock absorbing mechanism is applied is placed in any direction such as upper and lower, front and back, right and left as shown in FIGS. 2 to 4, the chassis 1 was horizontally sunken by its own gravity so that equal shock resistance characteristics could be obtained regardless of the direction in which the apparatus body is placed and vibration in any direction.

Further, if the attachment points a, b and c of the compression coil springs 2, 3 and 4 to the chassis 1 and the gravity of the chassis 1 are placed on the same plane, when the chassis 1 is placed vertically, a rotational moment is lost so that the chassis 1 is supported stably.

As an example, there can be realized a combination of compression coil springs and dampers in which transfer characteristics for all directions and all vibration directions achieve a resonance frequency of 20.4 Hz to 24.6 Hz and Q values of 5.4 dB to 6.8 dB.

Furthermore, according to this embodiment, since the chassis 1 is supported by the three compression coil springs 2, 3, 4 and the three dampers 5, 6, 7 that are disposed horizontally one another, the number of assembly parts can be reduced and the apparatus can be simplified in arrangement.

FIG. 5 shows another embodiment of the present invention. As shown in FIG. 5, on each of the left-hand side of the chassis 1 and the opposing right-hand side thereof are symmetrically attached two compression coil springs 10 and two dampers 11 serving as resilient members with respect to the chassis 1. In this case, if the compression coil springs and the dampers are disposed so that the gravities of the attachment points of the four compression coil springs 10 and the gravity of the chassis 1 become coincident with each other, there is then the advantage such that the four same compression coil springs 10 can be utilized. Also, it can be easily understood that similar action and effects to those of the first embodiment shown in FIG. 1 can be achieved.

FIG. 6 shows a portable optical disc driving apparatus as a practical example of electronic apparatus having the shock absorbing mechanism. FIG. 6 is a bottom view showing the inside of the portable optical disc driving apparatus from the rear side (bottom side).

As shown in FIG. 6, there is provided a mechanism unit 21. The mechanism unit 21 includes a chassis 22 on which there are mounted a disc loading mechanism, a disc rotation drive mechanism, a mechanism assembly parts forming a disc recording and reproducing mechanism or the like. A motor 23 is

adapted to rotate a disc (not shown) and an optical head attachment mount 24 is adapted to mount thereon an optical head device from which a laser light is radiated on the disc so that a signal is recorded on and/or reproduced from the disc. A guide shaft 25 is adapted to support the optical head attachment mount 24 such that the optical head attachment mount 24 can be moved in the diametrical direction of the disc. A translating mechanism 26 is comprised of a motor 26a and a screw shaft 26b rotated by the motor 26a and screwed into the optical head attachment mount 24, thereby translating the optical head attachment mount 24. A motor 27 is adapted to drive the disc loading mechanism.

A sub chassis (frame) 28 is shaped in box to construct an outer housing. The above-mentioned mechanism unit 21 is supported to the sub chassis 28 via two pairs of compression coil springs 29 and two damping mechanisms 30 provided on one side of the sub chassis 28 and one pair of compression coil spring 29 and one damping mechanism 30 on the other side of sub chassis 28.

FIG. 7 shows more in detail a structure of the supporting portions each being formed of the compression coil spring 29 and the damping mechanism 30.

As shown in FIG. 7, the damping mechanism 30 comprises a rod 31 and a damper body 34 made of a resilient member such as a synthetic rubber or the like into which there is sealed a viscous fluid 33 such as a silicon oil or the like. The rod 31 is projected from a side portion of the chassis 22 of the mechanism unit 21 (one side is a side plate portion 22a formed by bending the end portion of the chassis 22 and the other side is a leg piece portion 22b vertically erected on the chassis 22 as shown in FIG. 6). On the other hand, the damping body 34 is fixed to the inner surfac of the side portion of the sub chassis 28 through a fixed mount 35, and the top of the rod 31 is fitted into an engagement concave portion 34a formed at the central portion of the damper body 34.

The fixed mount 35 is attached to the sub chassis 28 by engaging a pair of hook-shaped fixed leg portions 36a, 36b protruded from the fixed mount 35 into groove portions 37a, 37b of the sub chassis 28, respectively.

On the fixed mount 35 is formed a wall portion 38 that surrounds the damper body 34. The wall portion 38 is elongated to the height sufficient that it covers substantially the whole surface of a peripheral wall portion 34b of the damper body 34 and that it opposes the top portion of the rod 31. The top portion of the rod 31 is fitted into the inside of the wall portion 38. Thus, the wall portion 38 can prevent the damper body 34 from being buckled by the vibration in the lateral direction as will be described later on.

On the other hand, the compression coil spring 29 is located to surround the rod 31 so as to hold therein the rod 31 as the core and interposed between the chassis 22 and the fixed mount 35 of the sub chassis 28 in a compressed fashion. A vibration transmitted from the outer sub chassis 28 to the mechanism unit 21 through the chassis 22 can be damped by the spring force of the compression coil spring 29.

When a vibration in the lateral direction, i.e., in the direction in which the damper body 34 is sheared is applied to the damper mechanism 30, the viscous fluid (oil) 33 within the damper body 34 is flowed in accordance with the movement of the rod 31 (in the direction shown by an arrow A in FIG. 7), thereby achieving a predetermined damping effect.

At that time, the wall portion 38 formed on the fixed mount 35 can prevent the damper body 34 from being buckled, thereby achieving a reliable damping effect. That is to say, if there is not provided the wall portion 38, if a vibration in the lateral direction is applied to a small damper which is applied to the portable disc driving apparatus of this embodiment, then when the rod 31 is moved in the arrow A direction, the peripheral wall portion 34b of the damper body 34 is moved, deformed and buckled together therewith as compared with the movement of the viscous fluid 33, thereby deteriorating the damping effect. However, since the damper body 34 is prevented from being buckled by the provision of wall portion 38, even the small damper can achieve the reliable damping effect.

Further, since the wall portion 38 is provided as an assembly part independent of the damper body 34, the value of the resonance frequency fO of the damper can be prevented from being increased and a satisfactory damping characteristic can be maintained.

Furthermore, the rod 31, for example, is projected from the inner surface side of the side portion of the sub chassis 28 and the damper body 34 is fixed to the side portion of the chassis 22 with effects similar to those of the aforesaid embodiments being achieved.

It is needless to say that the present invention is not limited to the shock absorbing device of the portable disc driving apparatus and may be applied to a variety of shock absorbing devices of various electronic apparatus.

Claims

1. A shock absorbing device comprising:
   a) a chassis (1,22);
   b) a frame (8,28) surrounding the chassis (1,22); and
   c) a plurality of supporting means for resiliently supporting one side of the chassis and the opposing other side of the chassis (1,22) to the frame (8,28), wherein the supporting

means each comprise a rod (5a,6a,7a,31), a damper (5,6,7,30) formed of a resilient member (5b,6b,7b,34) and having an engagement concave portion (5c,6c,7c,34a) into which the rod (5a,6a,7a,31) is fitted, and a coil spring (2,3,4,29) surrounding the rod and being disposed between the chassis (1,22) and the frame (8,28) under compressed state, the coil springs (2,3,4,29) having spring constants of the shearing direction respectively set in response to the direction of the action of gravity on the chassis (1,22), and being disposed at one side and the other opposing side of the chassis (1,22) so that the compressing directions of the coil springs (2,3,4,29) are opposed to each other.

2. A shock absorbing device according to claim 1, wherein each of the dampers includes a container into which a viscous fluid is sealed and each of said coil springs is held between said container and said chassis so as to hold said rod as a shaft.

3. A shock absorbing device according to claim 1, wherein said chassis has at least a pair of opposing side surfaces and at least one supporting means or more are respectively disposed between one side surface of said chassis and an inner side surface of said frame and the other side surface of said chassis and the inner side surface of said frame.

4. A shock absorbing device according to claim 3, wherein said coil springs are respectively attached between said chassis and said frame such that a total loads of loads applied to the coil spring disposed on one side surface of said chassis in the compression direction and a total load of loads applied to the coil springs disposed on the other side surface of said chassis in the compression direction become substantially equal to each other.

5. A shock absorbing device according to claim 4, wherein said coil springs are respectively attached between the chassis and the frame such that respective attaching positions to said chassis and the gravity of said chassis are set on the same plane.

6. A shock absorbing device according to claim 3, wherein said coil springs have constant ratios of gravities applied to their attaching positions to said chassis and spring constants of the shearing direction of said coil springs.

7. A shock absorbing device according to claim 1, wherein said damper includes a damper body formed of a resilient member and into which a viscous fluid is sealed and said damper body is fixed to the inner surface side of said frame through a mount.

8. A shock absorbing device according to claim 7, wherein said rod is projected from one side and the other side of said chassis and a top thereof is fitted into said engagement concave portion of said damper.

9. A shock absorbing device according to claim 7, wherein said mount includes a pair of leg portions and is attached to said chassis by engaging the pair of leg portions into groove portions formed through said chassis.

10. A shock absorbing device according to claim 7, wherein said mount includes a wall portion covering a peripheral wall portion of said damper body and said wall portion is mounted on said mount to have a height sufficient so that said mount opposes said rod under the condition that said rod is fitted into said engagement concave portion of said damper.

11. A shock absorbing device according to claim 1, wherein said chassis has a disc driving mechanism mounted thereon.

FIG. 1

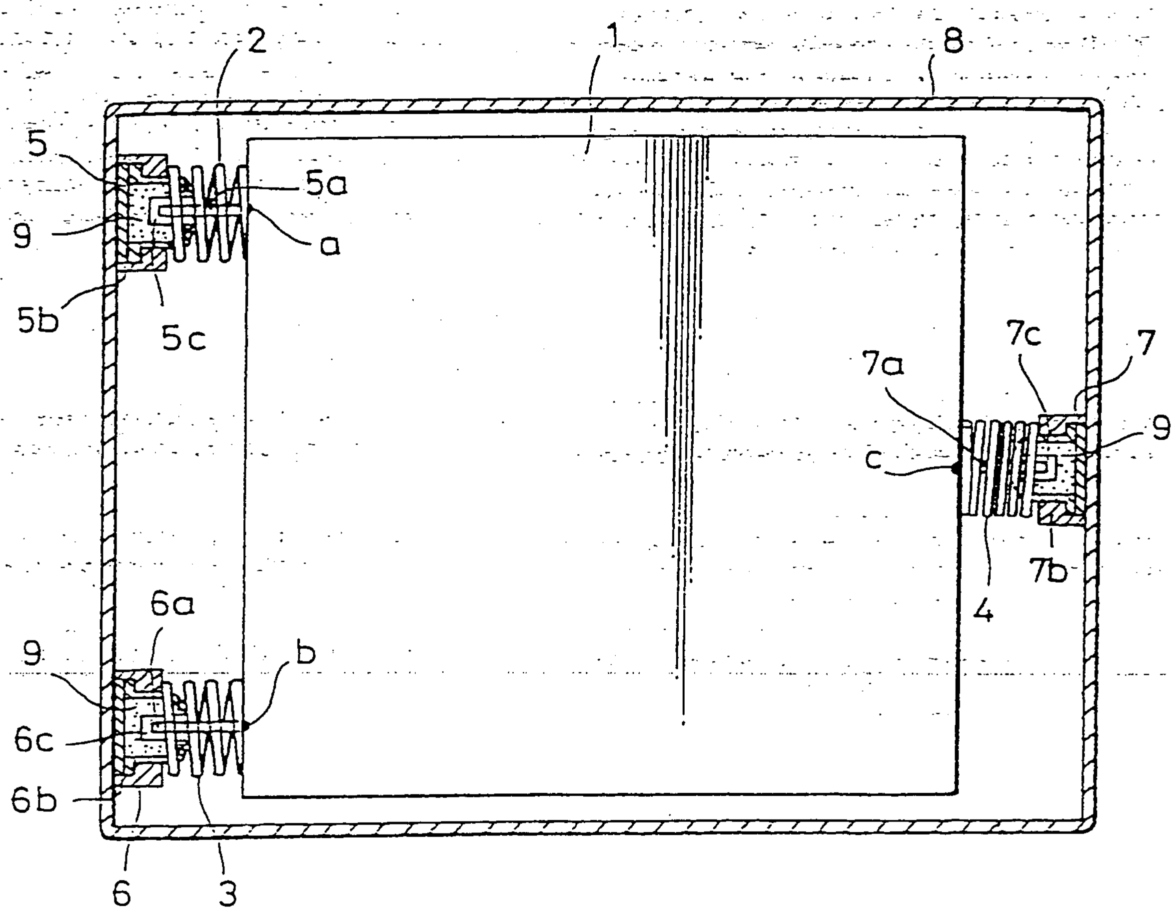


FIG. 2

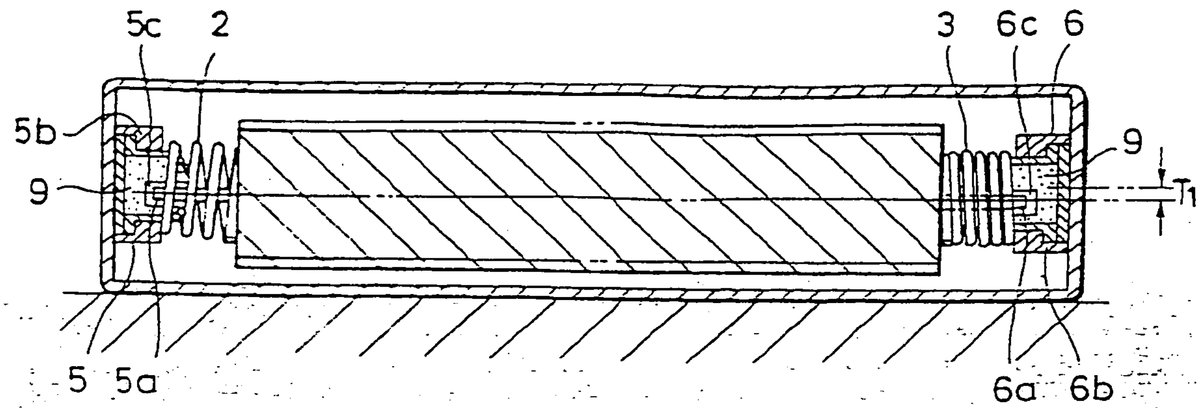
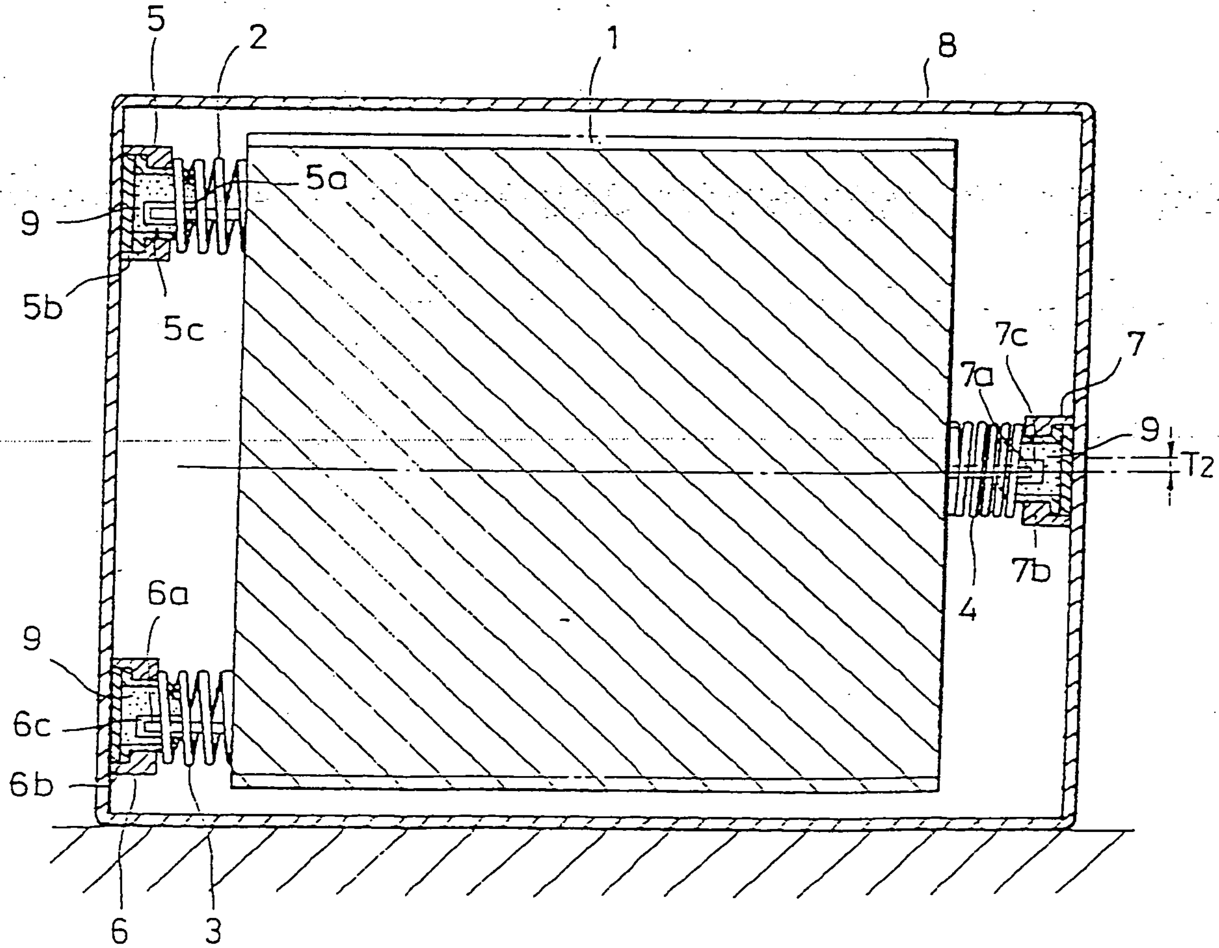

5c
2
3
6c
6
5b
9
9
T1
5
5a
6a
6b

FIG. 3


5
2
1
8
5a
9
5b
5c
7c
7
7a
9
T2
7b
4
6a
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6c
6b
6
3

FIG. 4

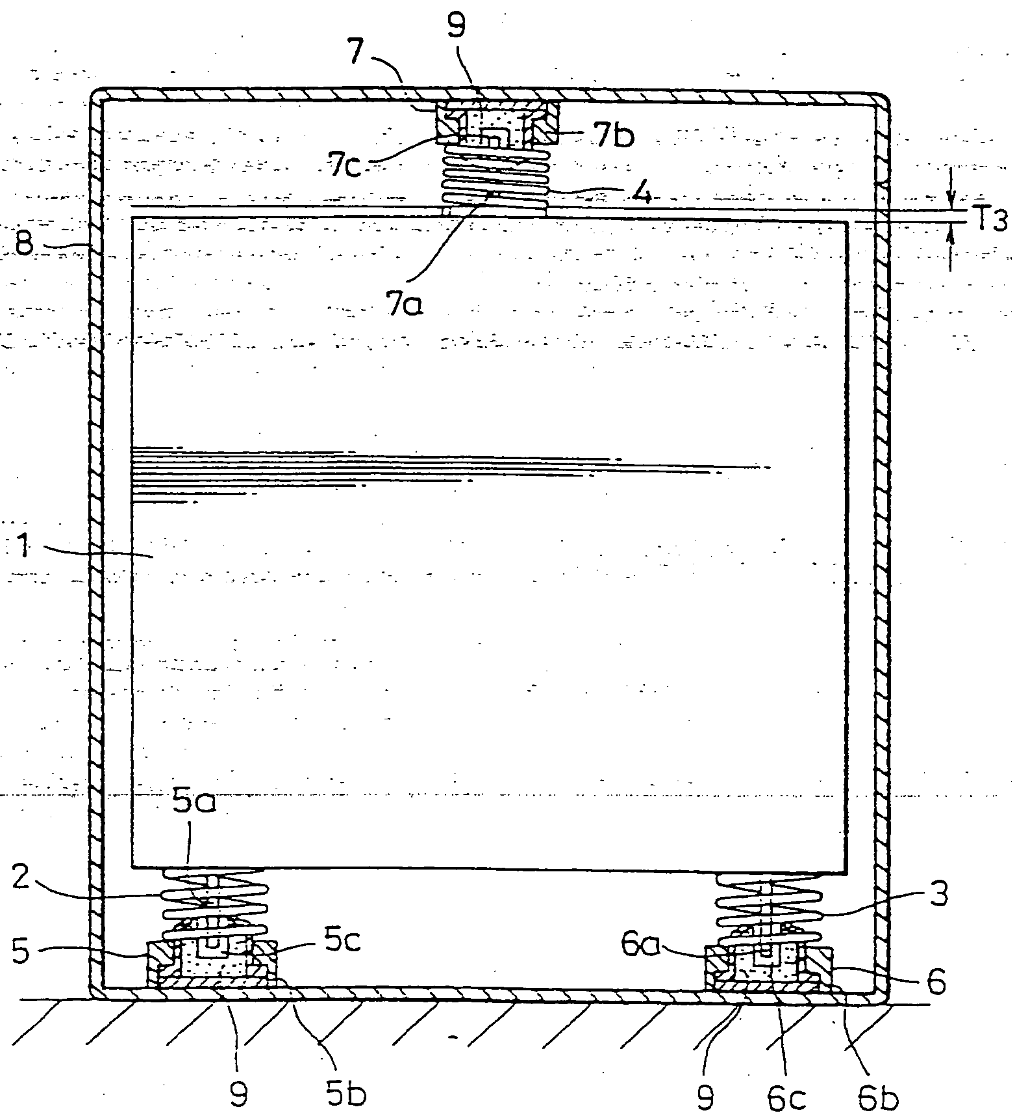


FIG. 5

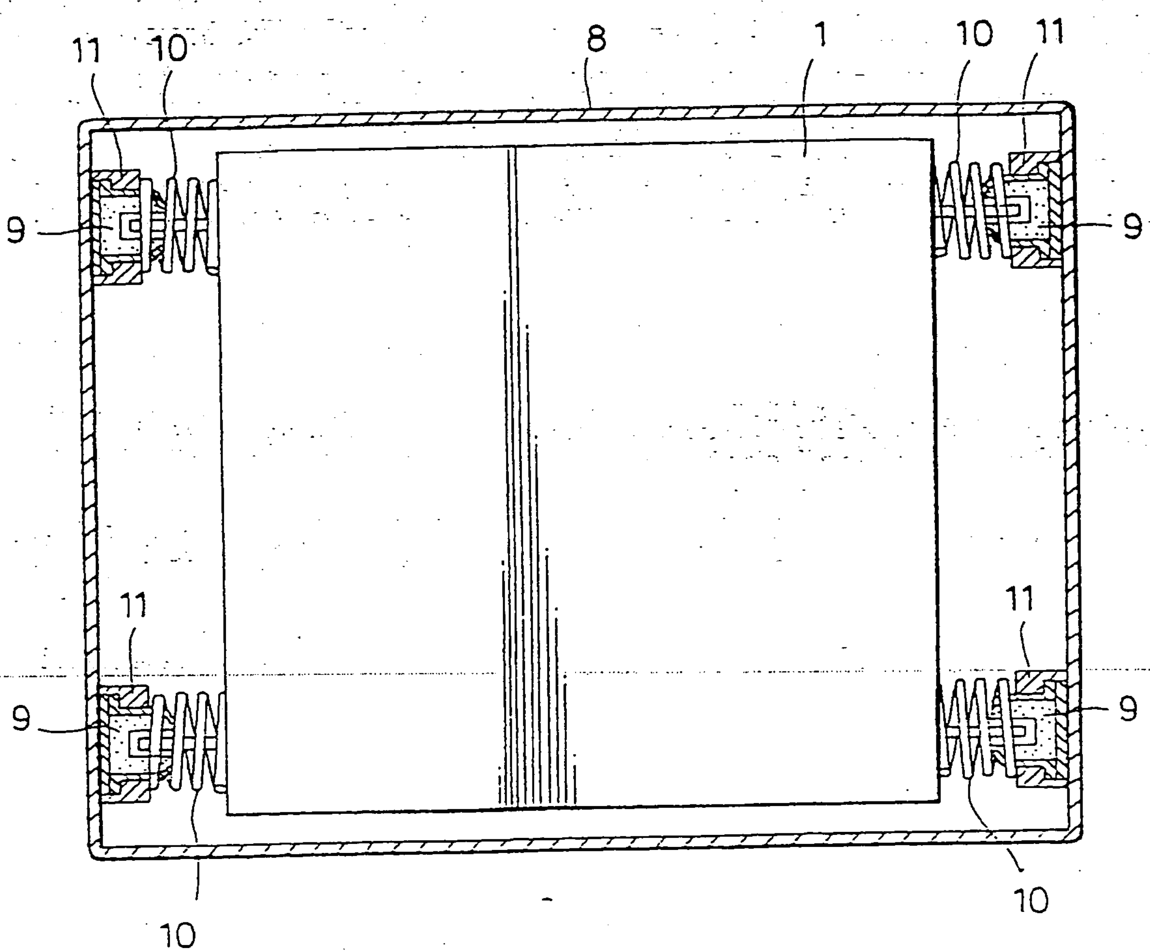


FIG. 6

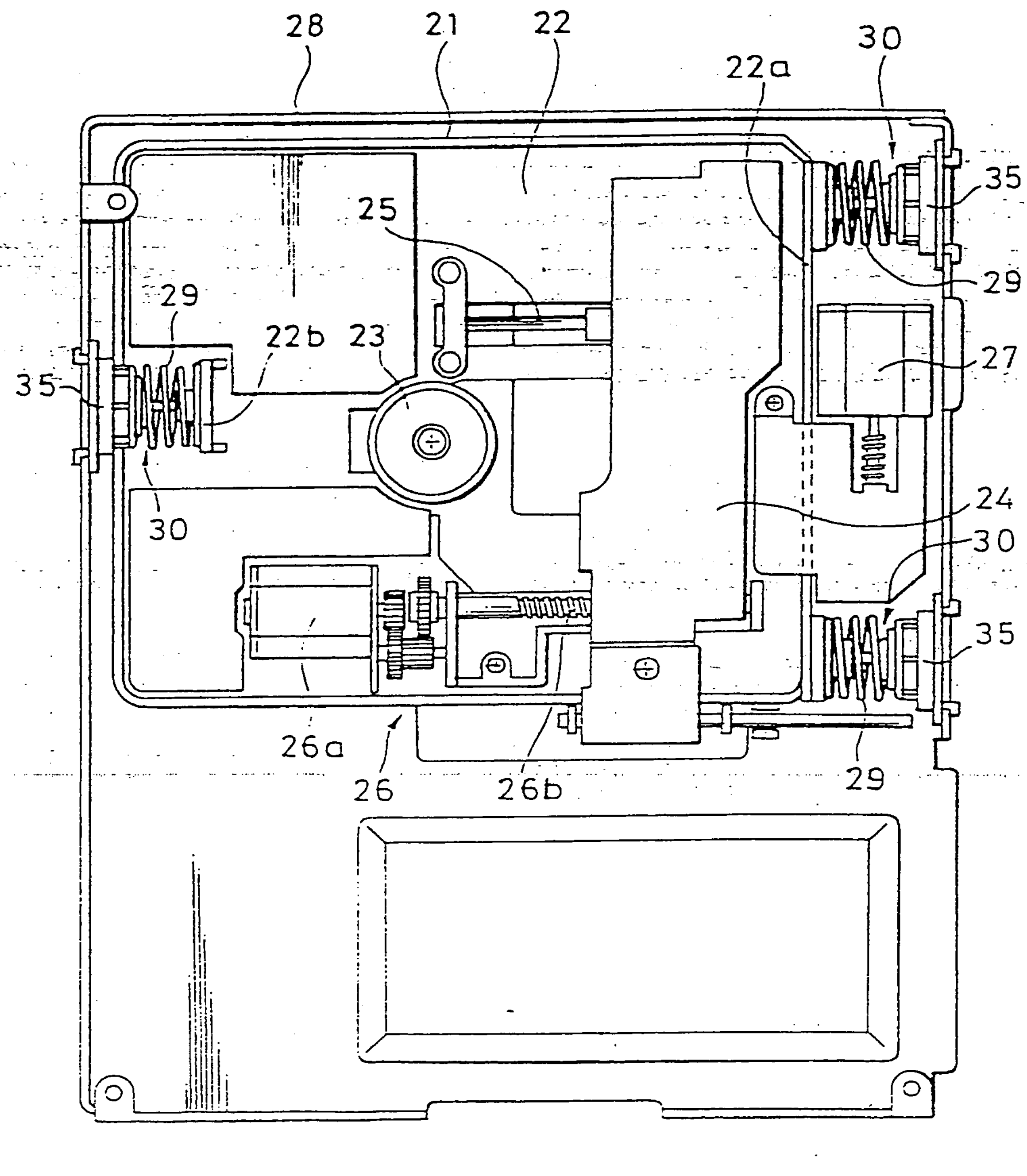
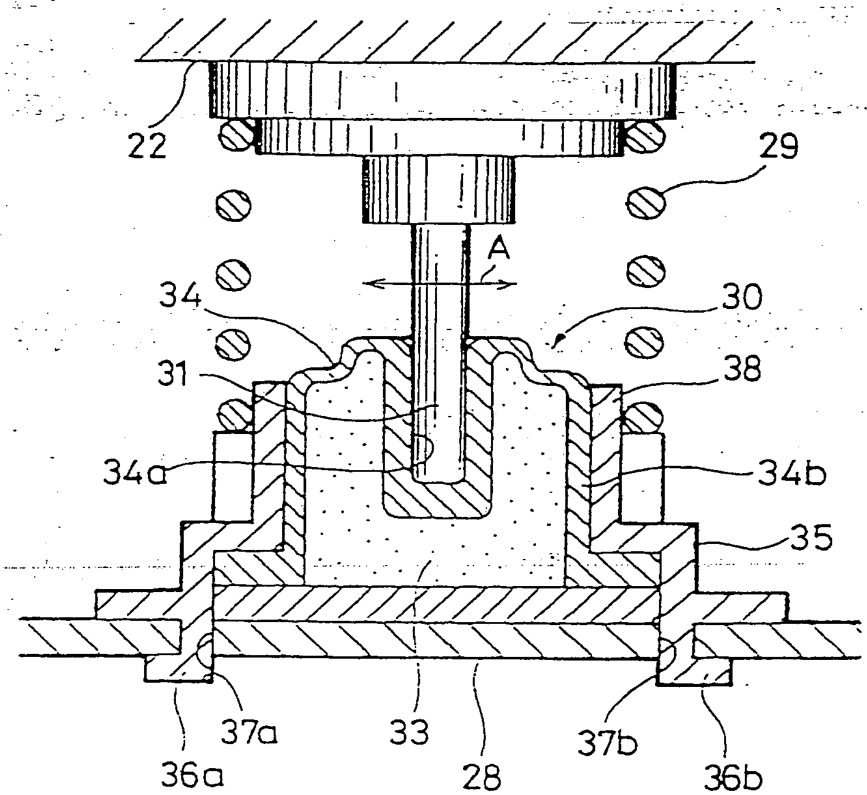


FIG. 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 6372

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 11, no. 397 (M-655)25 December 1987 & JP-A-62 165 040 (MATSUSHITA ELECTRIC IND. CO. LTD.) 21 July 1987 * abstract *	1,3,4,7, 8	G11B33/08
Y	IBM TECHNICAL DISCLOSURE BULLETIN vol. 33, no. 9, February 1991, NEW YORK US pages 53 - 57 ANON. 'Frictional - elastomeric shockmount system for mechanical isolation of a fragile device from sources of vibration and shock'	1,3,4,7, 8	
A	* the whole document *	5,6	
A	EP-A-0 197 159 (SONY CORP.) * abstract; figures 3,6A *	2,11	
D	& US-A-4 731 777		
A	US-A-4 893 210 (MINTZLAFF, R.P.)	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G11B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	22 NOVEMBER 1993	DEANE I.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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